Recent climatological trend of the Saharan Heat Low and its impact in West African climate

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Motivation

The Saharan Heat Low (SHL) plays a pivotal role in the West African Monsoon system in spring and summer. Its intra-seasonal pulsations impact the wind fields, the convection and the dust outburst. But what is the temporal evolution of the HL intensity in a climat perspective ? and are the climate models able to represent correctly both the evolution and the impacts of the SHL pulsations ? In this study we will :

1. **analyse the recent trend of the HL at different time scales**
   - reanalysis (ERAI, NCEP2)
   - 15 climat models (AMIP from CMIP5 exercise)
2. **assess the quality of the climate models to represent the impacts of the SHL pulsations**

Data and tools

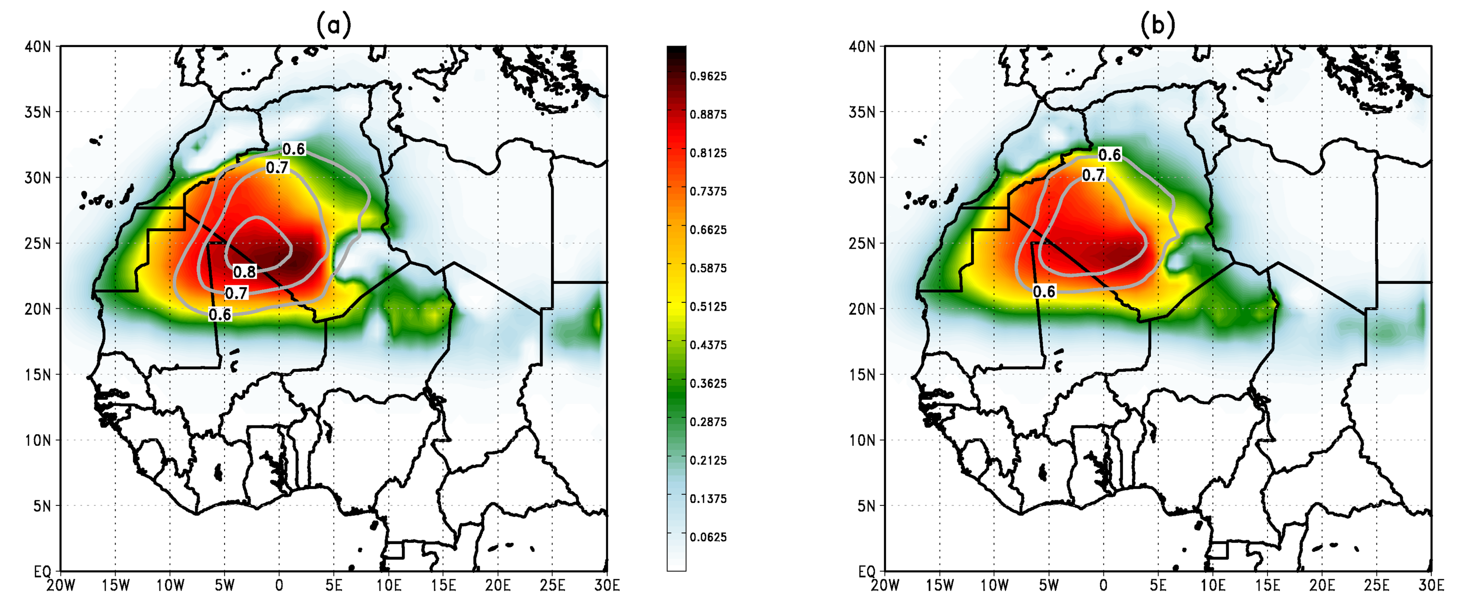
- models
  - ERA Interim and NCEP2 reanalysis
  - 15 climate models AMIP (SST forced) from the CMIP5 exercise
- observations
  - GPCC daily precipitation
- LLAT based on Lavaysse et al., 2009

$HL_{int} = Z_{700hPa} - Z_{925hPa}$

- Decomposition of the pulsations in three band periods
  - high band pass : < 25 days (intra-seasonal time scale)
  - intermediate band pass : (25 > x > 100 days)
  - low band pass : > 365 days (inter annual and decenal time scales)

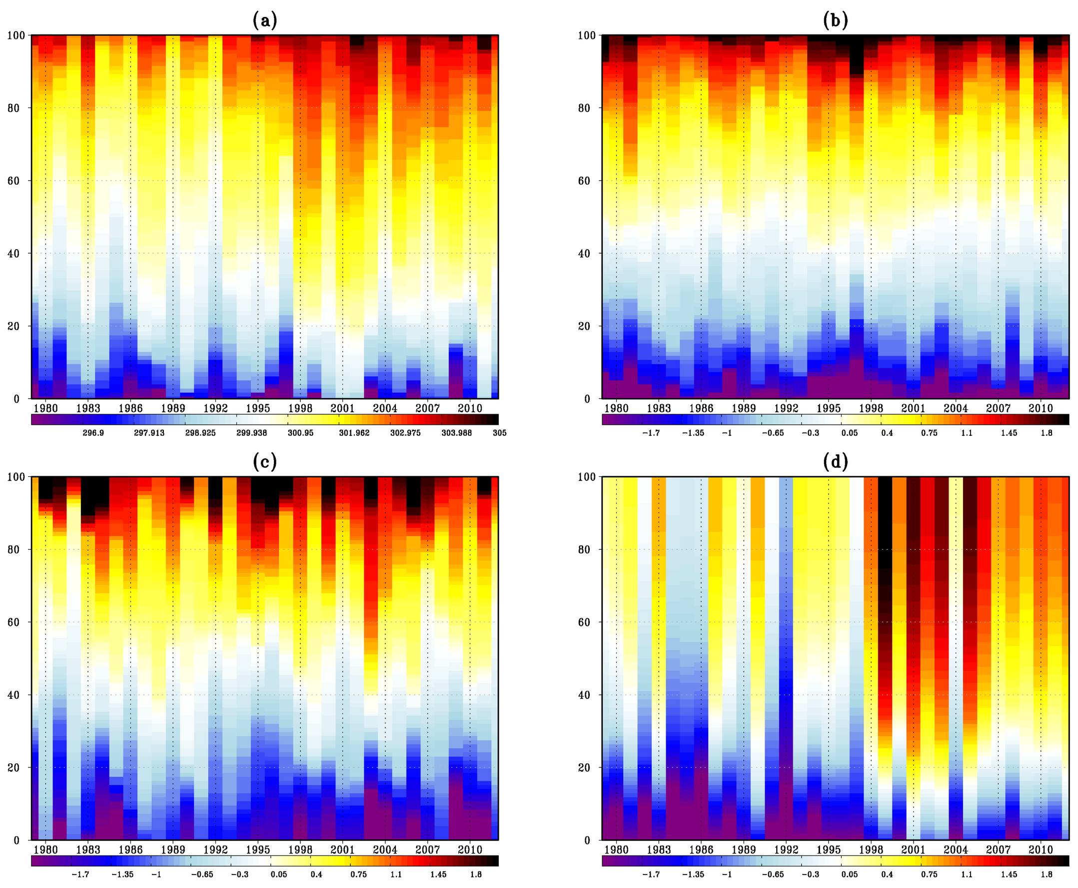
Climatological location of the SHL in summer using ERAI and NCEP2 →

Saharan Heat Low detection and characterization

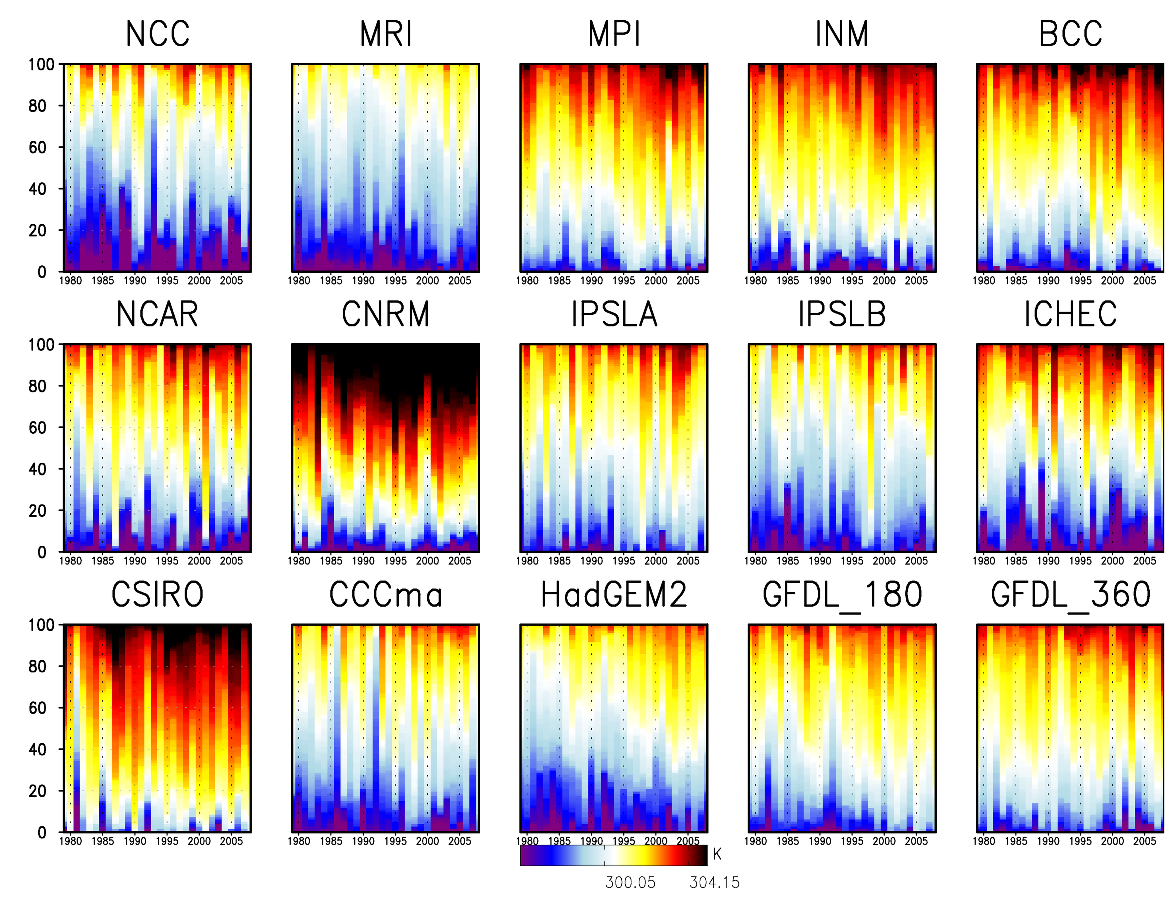


Recent evolution of the SHL

CDF of the HL intensity using ERAI and the unfiltered signal(a), low-band-pass (b), intermediate (c), and high-band-pass (d)

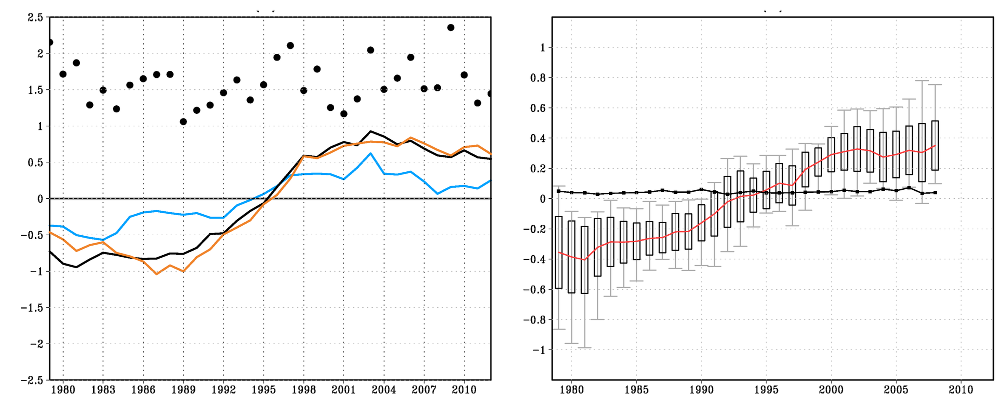


CDF of the HL intensity using the 15 climate models, using the unfiltered signals (same as figure previously panel a)



In reanalysis

- Intensification of the SHL during the 90's observed in ERAI and NCEP2
- Not associated with a modification of the SHL pulsations at intra-seasonal time scales

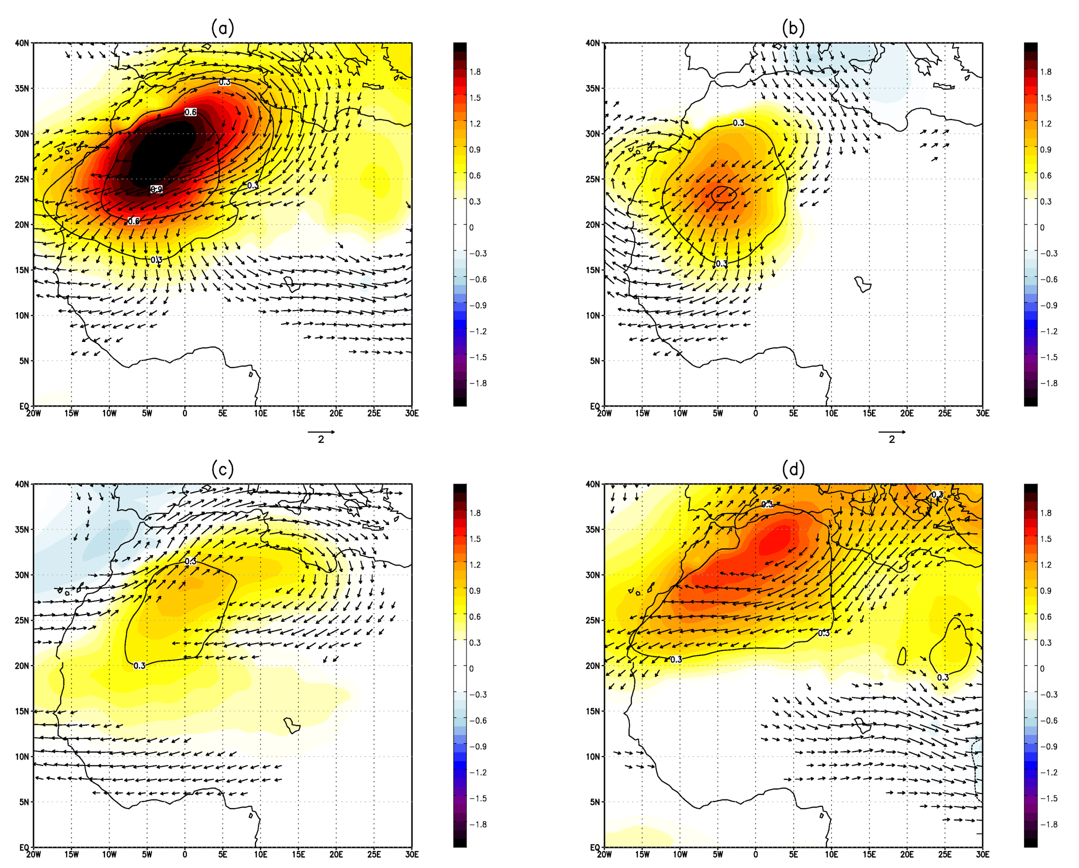


In climate models

- Large (positive or negative) bias of the SHL intensity
- Trend **well** represented in the climate models (using the ensemble mean and several individual members)
- **More uncertainties** to represent the spatial patterns (not shown)

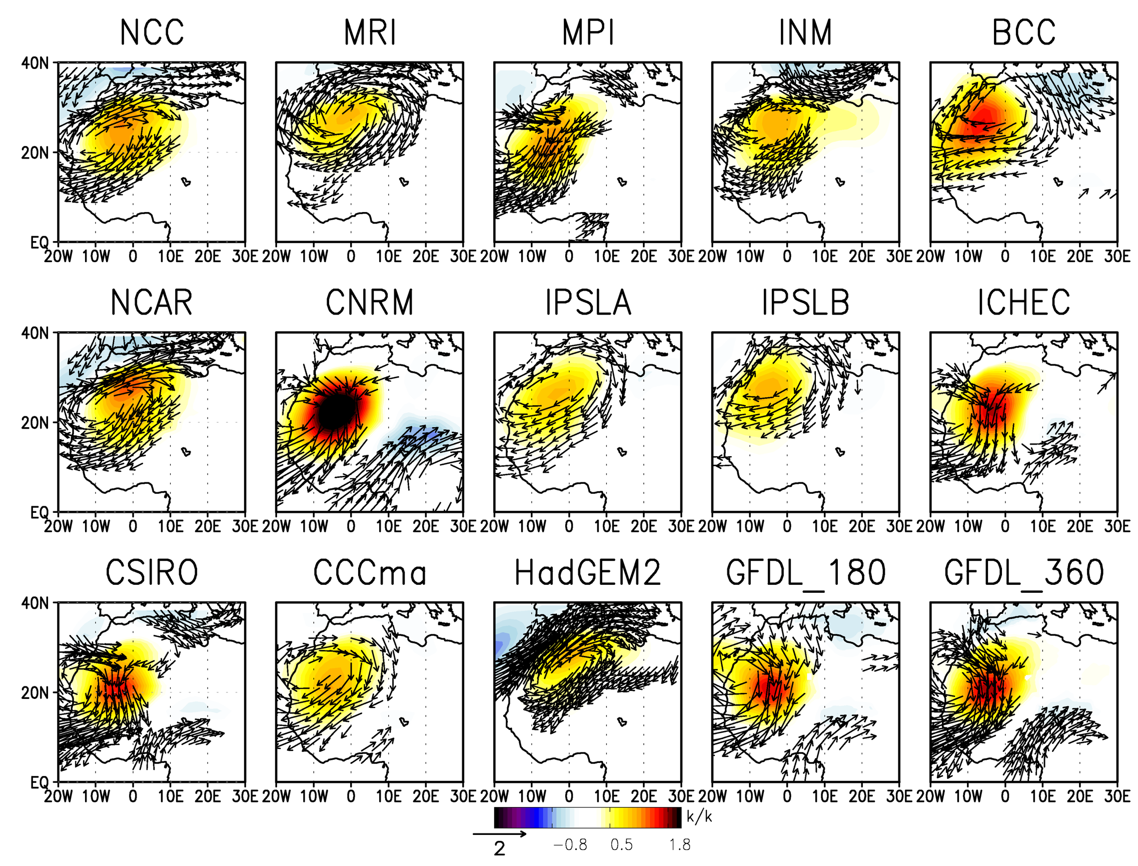
Impact on the WAM

Impact of the SHL pulsations, expressed by the 2D regression map of the SHL onto the Wind@700hPa and Temp@850hPa at different time scales (unfiltered, <25, 25-100, >365d)



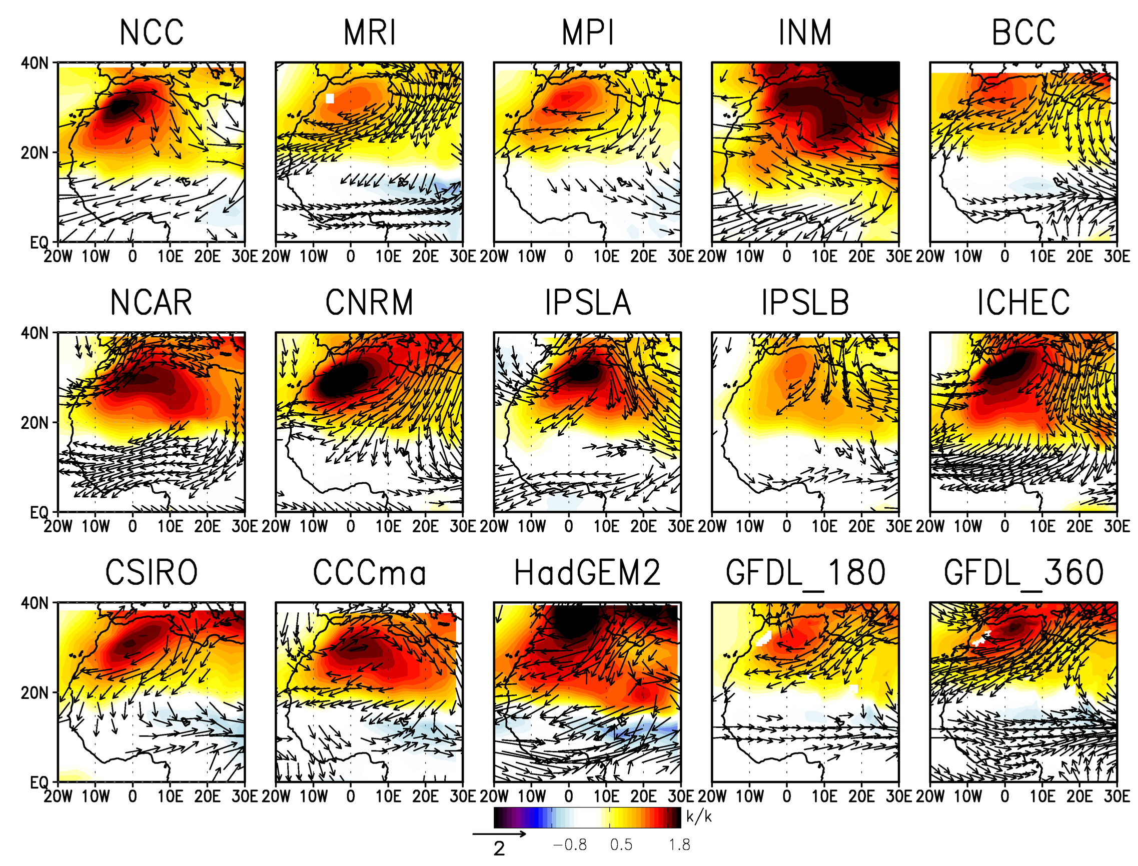
Unfiltered signal mainly explained by the low-band-pass filter signal. High-band-pass mainly regional.

Same as previously but for the 15 climate models, only the results with the high-band-pass filter are shown. The results highlight the impacts of the intra-seasonal pulsations.



Large uncertainties of the intensity of the regression. Impact correctly represented only over the North-Eastern part of the domain.

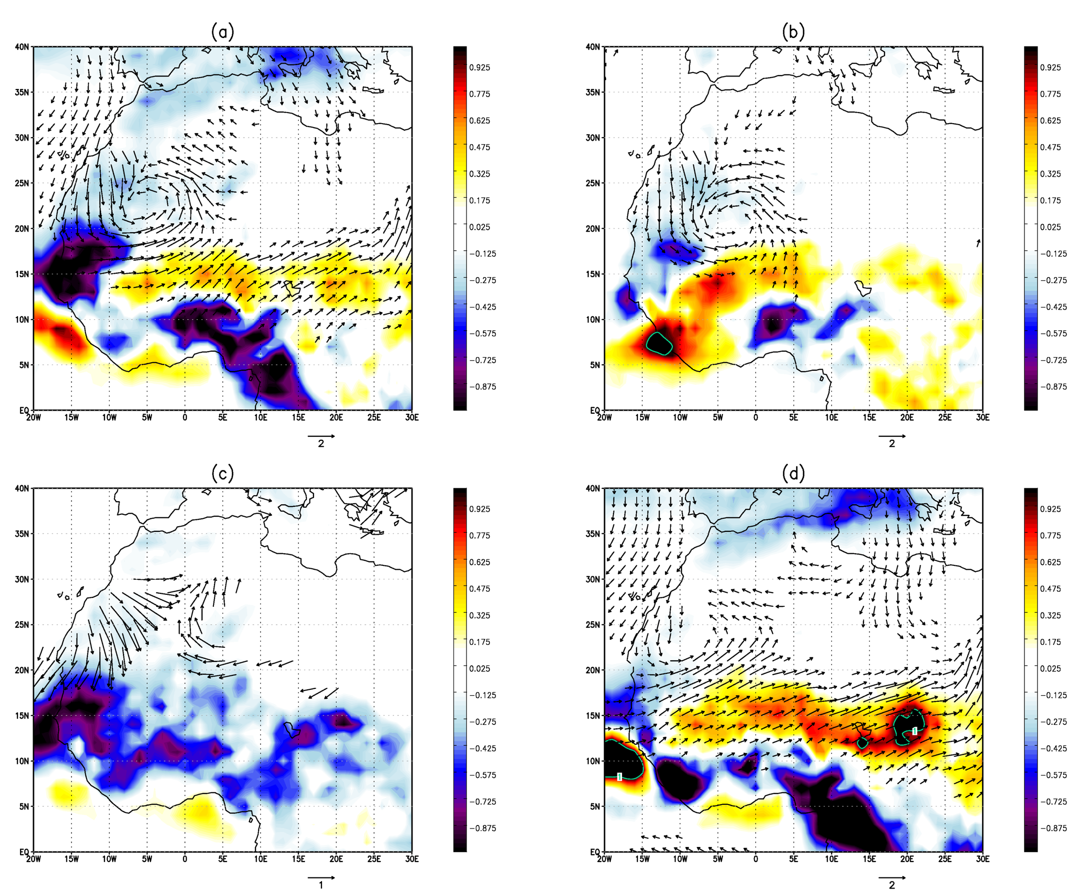
Same as previously but using the low-band-pass filter. The objective is to analyse the impacts associated with the inter-annual or decenal increase.



Impacts significant North to 20°N, with generally a maximum over the Atlas chain. Larger uncertainties in the wind fields over the Sahel.

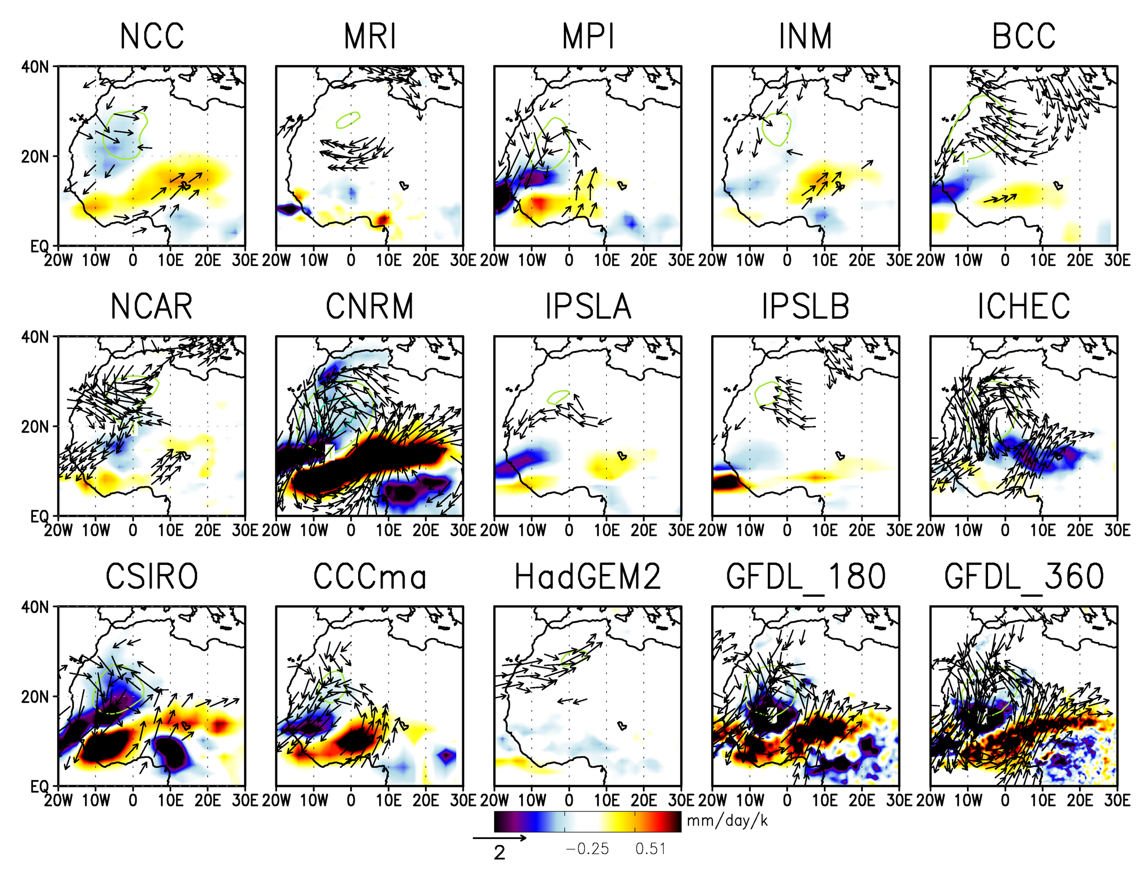
Impact on the convection

2D regression of ERAI onto the Wind@925hPa and the precipitation using the unfiltered and filtered signals



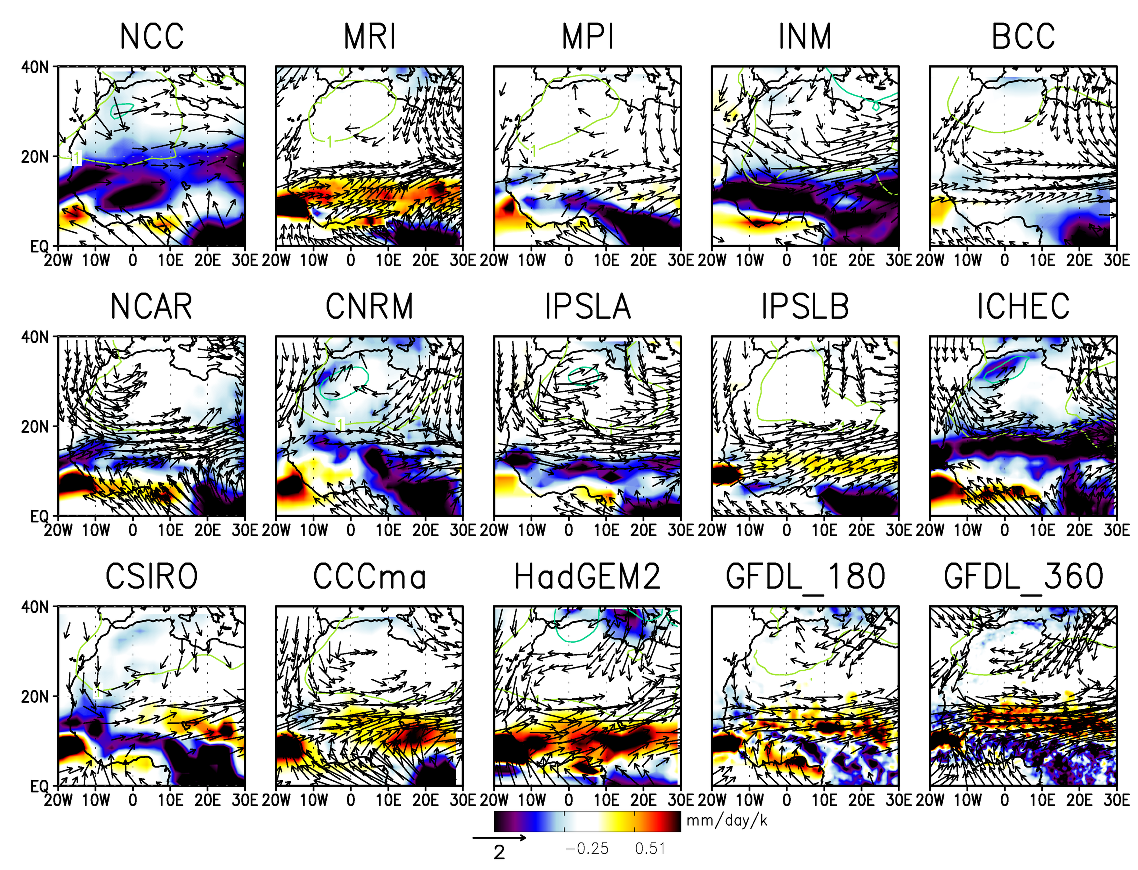
Contribution of all the filtered signals. Origin of the 25-100-day signal (c) not clear (MJO ?).

2D regression of the climate models onto the Wind@925 and precipitation using the high-band-pass filtered signals.



Same pattern of rainfall but difference in term of intensity. Cyclonic circulation but disagreement of the location of the centre.

2D regression of the climate models onto the Wind@925 and precipitation using the low-band-pass filtered signals.



Two groups of models with opposite responses (positive or negative anomalies → large uncertainties)

Conclusions and perspercTives

✔ **Uncertainties of the climate models to locate the increase of temperature**
✔ **Scores of the models change following the frequencies of the pulsations studied**

➔ **Same study with the others main components of the WAM system (AEWs, ...)**
➔ **First assessment of the futur trend of precipitation based on predictors**

Lavaysse et al: Recent climatological trend of the Saharan Heat Low and its impact on the West Africa climate, sub. to Climate Dynamics

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